Updated Overview of Management of Clubfoot using Ponseti method

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Abstract

Background: Idiopathic congenital talipes equinovarus (clubfoot) is one of the most common congenital skeletal deformities, it is mainly characterized by cavus, forefoot adductus, hindfoot varus and equinus. Its overall incidence is 1 to 2 in 1000 live births. The cause of idiopathic clubfoot is not clearly known and it remains controversial. Main pathological changes include; that talar neck is medially and plantarly deviated, and the talar body is laterally rotated, calcaneus is in varus and rotated medially around talus. The Ponseti method has been recognized as most effective technique for the management of clubfoot; manipulation, serial casting, and braces.

Keywords: Ponseti method, Clubfoot

Background

An understanding of the pathologic anatomy of clubfoot and its deviation from the normal are essential in order to formulate a method of treatment that will fulfill the goal of restoring normal anatomy and normal function to the foot. (1)
The deformity may be resulted from an abnormal relationship between tarsal bones associated with soft tissues contractures. Twisting of the calcaneus and the navicular around the talus as congenital dislocation of the talocalcaneonavicular joint. (2)
The kinematics are greatly altered by the severe shortening of the medial and posterior tarsal ligaments and by the tightness of the tibialis posterior and gastrosoleus muscles. The fibrotic and contracted deltoid ligament holds the calcaneus in inversion. The navicular is held severely medially displaced and inverted by the fibrosis of the tibionavicular, the plantar calcaneonavicular ligaments, and the pull of the tight tibialis posterior tendon. (3)
In the sections of the fetuses studied, the talocalcaneal interossei, the bifurcate, and the naviculocuboid ligaments do not usually participate in the fibrosis. However, owing to the interdependence of the tarsal joints, the displacement of the navicular induces medial displacement and inversion of the cuboid and of the calcaneus. Invariably, the navicular and cuboid are severely medially displaced as well as inverted. The shape of the talar joint surfaces is changed, now adapting to the altered position of the tarsal elements. (4)
The mobility of the posterior part of the foot is very restricted. In the severely supinated tarsus of a clubfoot, the range of passive motion varies greatly. Only a few degrees of passive abduction can be obtained in the tarsi of rigid feet, while 20 to 30 degrees are reached in less severe cases. Even with forced abduction, the tarsus of an untreated clubfoot cannot be moved to a neutral, normal position. Although the tarsal bones are displaced and the tarsal joints are misshaped, they are congruent in the clubfoot position. In this position both the talonavicular and the talocalcaneal joints are in a close-packed
position. The deformed surfaces of the calcaneocuboid joint are in restricted contact only. The joints become incongruent when correction of the deformity is attempted unless the correction is made gradually for several months allowing for the gradual remodeling of the joint surfaces. A surgical realignment of the skeletal elements requires severing most tarsal ligaments, causing all the tarsal joints to subluxate into a wholly unstable position. (4)

The ligaments of the joints between the navicular and the cuneiforms, and those at the Lisfranc line and in the toes, are not involved in the fibrosis that affects mostly the hindfoot. Although adducted, the forefoot is less supinated than the hindfoot. Thus, a cavus results with the first metatarsal in greater plantar flexion than the lateral metatarsals. The joints of the anterior part of the foot are nearly normal even though the first cuneiformetatarsal joint may be medially slanted in some clubfeet, as observed in many feet with metatarsus adductus. (4)

In the clubfoot, active and passive mobility of the anterior part of the foot and toes is only slightly restricted. In most cases at birth, the forefoot adduction can be corrected to a near normal position at the Lisfranc line, and the metatarsals can be flexed and extended through a normal range of motion. Even in cases where the first cuneiformetatarsal joint is medially slanted, the first metatarsal can be moved into the proper alignment with the other metatarsals, thereby eliminating the cavus. (4)

**Treatment of clubfoot**

**Non-operative Treatment**

The initial treatment of congenital club foot should be nonoperative, beginning in the first day of life so as to take advantage of the favorable fibroelastic properties of the connective tissue which forms the ligaments, joint capsules and tendons. (5) The first three months of life offer the skilled and knowledgeable surgeon a golden opportunity to correct the deformity by manipulation and casting. Proper manipulative techniques followed by applications of well moulded plaster casts offer the best and safest correction of most clubfeet in infants (5).

**Ponseti method**

The four basic deformities are cavus, adductus, varus, and equinus (CAVE), describing both the clinical position of the foot and outlining the general order of deformity correction, starting with cavus (6). The results of treatment are enhanced by starting within the first month of life and depend on the understanding of the pathoanatomy and that correction requires a sequential methodology (7).

Manipulation lasts for 1–3 minutes and includes stretching of tight ligaments. Cavus is corrected by elevating the first metatarsal; thus, the forefoot, in the first session. At successive weekly (or 5–7 days) intervals, the calcaneus, navicular and cuboid are gradually displaced laterally (8).

There are three crucial points: forefoot abduction is performed with slight supination (not pronation); equinus is maintained as long as the heel is in varus, allowing the calcaneus to move freely under the talus; and counter pressure on the lateral head on the talus, not on the lateral column, which hinders the correction of the heel varus (9).

Equinus is the last to be corrected and should be attempted when the hindfoot is in slight valgus and the forefoot abducted 70° relative to the leg. This degree of hyperabduction is considered necessary to prevent recurrence of the deformity. In 85–90% of patients, a percutaneous Achilles tendon lengthening is performed. After each manipulation, a well-moulded toe-to-groin cast maintains the foot in abduction and enables moulding of the joints. To prevent recurrence after full correction is obtained, a Foot Abduction Orthosis (i.e., Denis Browne bar) should hold the forefoot externally rotated 60–70° permanently for three months and during naps and overnight for 3–4 years (10).
Ignacio Ponseti (Iowa, USA) developed a method of serial manipulation and casting in the 1950s. The principal features of his technique are based on correct understanding of the functional anatomy of the foot (11).

**Scientific basis of Ponseti management:**
The treatment of clubfoot is based on the biology of the deformity and of the functional anatomy the foot (12).

**Details of the Ponseti technique:**
1. **The first phase during which deformity is corrected completely:**

   **First four or five casts (more if necessary):**
   Start as soon after birth as possible. Make the infant and family comfortable. Allow the infant to feed during the manipulation and casting processes. Casting should be performed by the surgeon. Each step in management is shown for both the right and left feet (13).

   **Reduce the cavus:**
   The first element of management is correction of the cavus deformity by positioning the forefoot in proper alignment with the hindfoot. The cavus, which is the high medial arch is due to the pronation of the forefoot in relation to the hindfoot. The cavus is always supple in newborns and requires only supinating the forefoot to achieve a normal longitudinal arch of the foot. In other words, the forefoot is supinated to the extent that visual inspection of the plantar surface of the foot reveals a normal appearing arch—neither too high nor too flat. Alignment of the forefoot with the hindfoot to produce a normal arch is necessary for effective abduction of the foot to correct the adductus and varus (14).

   **Second, third, and fourth casts:** During this phase of treatment, the adductus and varus are fully corrected. The distance between the medial malleolus and the tuberosity of the navicular when palpated with the fingers tells the degree of correction of the navicular. When the clubfoot is corrected, that distance measures approximately 1.5 to 2 cm and the navicular cover the anterior surface of the head of the talus (15).

   **Adductus and varus:** Note that the first cast shows the correction of the cavus and adductus. The foot remains in marked equinus. Casts 2 through 4 show correction of adductus and varus (6).

   **Equinus:** The equines deformity gradually improves with correction of adductus and varus. This is part of the correction because the calcaneus dorsiflexes as it abducts under the talus. No direct attempt at equines correction is made until the heel varus is corrected (6).

   **Foot appearance after the fourth cast:** Full correction of the cavus, adductus, and varus are noted. Equinus is improved, but this correction is not adequate, necessitating a heel cord tenotomy. In very flexible feet, equines may be corrected by additional casting without tenotomy. When in doubt, perform the tenotomy (16).
Cast application, molding, and removal:
Success in Ponseti management requires good casting technique. Those with previous clubfoot casting experience may find it more difficult than those learning clubfoot casting for the first time (16). Ponseti recommend that plaster material be used because the material is less expensive, and plaster can be more precisely molded than fiberglass (14).

Manipulation:
The manipulation consists of abduction of the foot beneath the stabilized talar head. Locate the head of the talus. All components of clubfoot deformity, except for the ankle equines, are corrected simultaneously. To gain this correction, you must locate the head of the talus, which is the fulcrum for correction (12).

Exactly locate the head of the talus:
This step is essential. First, palpate the malleoli with the thumb and index finger of hand A while the toes and metatarsals are held with hand B. Next, slide your thumb and index finger of hand A forward to palpate the head of the talus (red) in front of the ankle mortise. Because the navicular is medially displaced and its tuberosity is almost in contact with the medial malleolus, you can feel the prominent lateral part of the talar head barely covered by the skin in front of the lateral malleolus. The anterior part of the calcaneus will be felt beneath the talar head (11).
While moving the forefoot laterally in supination with hand B, you will be able to feel the navicular move ever so slightly in front of the head of the talus as the calcaneus moves laterally under the talar head (17).

Stabilize the talus: Place the thumb over the head of the talus, as shown by the yellow arrows in the skeletal model. Stabilizing the talus provides a pivot point around which the foot is abducted. The index
finger of the same hand that is stabilizing the talar head should be placed behind that lateral malleolus. This further stabilizes the ankle joint while the foot is abduced beneath it and avoids any tendency for the posterior calcaneal-fibular ligament to pull the fibula posteriorly during manipulation (18).

![Image](image_url)

**Fig. (2):** Stabilizing the talus provides a pivot point around which the foot is abduced by placing the thumb over the head of the talus, as shown by the yellow arrows in the skeletal model (13).

**Manipulate the foot:** Next, by abducting the foot in supination, with the foot stabilized by the thumb over the head of the talus, abduct the foot as far as can be done without causing discomfort to the infant. Hold the correction with gentle pressure for about 60 seconds, then release. The lateral motion of the navicular and of the anterior part of the calcaneus increases as the clubfoot deformity corrects. Full correction should be possible after the fourth or fifth cast. For very stiff feet, more casts may be required. The foot is never pronated (16).

**Cast application rules:**

**Preliminary manipulation:** Before each cast is applied, the foot is manipulated.

**Applying the padding:** Apply only a thin layer of cast padding to make possible effective molding of the foot. Maintain the foot in the maximum corrected position by holding the toes while the cast is being applied (12).

**Applying the cast:** First apply the cast below the knee and then extend the cast to the upper thigh. Begin with three to four turns around the toes, and then work proximally up the leg. Apply the plaster smoothly. Add a little tension to the turns of plaster above the heel. The foot should be held by the toes and plaster wrapped over the "holder's" fingers to provide ample space for the toes (12).

**Molding the cast:** Do not try to force correction with the plaster. Use light pressure. Do not apply constant pressure with the thumb over the head of the talus; rather, press and release repetitively to avoid pressure sores of the skin. Mold the plaster over the head of the talus while holding the foot in the corrected position. Note that the thumb of the left hand is molding over the talar head while the index finger of the left hand is molding above the calcaneus. The arch is well molded to avoid flatfoot or rocker-bottom deformity. The index finger of the right hand is maintaining the correction. There is no pressure over the calcaneus. The calcaneus is never touched during the manipulation or casting. Molding should be a dynamic process; constantly move the fingers to avoid excessive pressure over any single site. Continue molding while the plaster hardens (16).
Extend cast to thigh: Use much padding at the proximal thigh to avoid skin irritation. The plaster may be layered back and forth over the anterior knee for strength (and for avoiding a large amount of plaster in the popliteal fossa area, which makes cast removal more difficult (16).

Trim the cast: Leave the plantar plaster to support the toes, and trim the cast dorsally to the metatarsal phalangeal joints, as marked on the cast. Use a plaster knife to remove the dorsal plaster by cutting the center of the plaster first and then the medial and lateral plaster. Leave the dorsum free. Note the appearance of the first cast when completed. The foot is in equines, and the forefoot is fully supinated (19).

Cast removal:
Remove each cast in clinic just before a new cast is applied. Avoid cast removal before clinic because considerable correction can be lost from the time the cast is removed until the new one is applied. Although a cast saw can be used, use of a plaster cast knife is recommended because it is less frightening to the infant and family and also less likely to cause any accidental injury to the skin. Soak the cast in water for about 20 minutes, and then wrap the cast in wet clothes before removal. Use the plaster knife and cut obliquely to avoid cutting the skin. Remove the above-knee portion of the cast first. Finally, remove the below-knee portion of the cast (20).

Decision to perform tenotomy:
A major decision point in management is determined when sufficient correction has been obtained to perform a percutaneous tenotomy to gain dorsiflexion and to complete the treatment. This point is reached when the anterior calcaneus can be ab ducted from underneath the talus. This abduction allows the foot to be safely dorsiflexed without crushing the tarsals between the calcaneus and tibia. If the adequacy of abduction is uncertain, apply another cast or two to be certain (21).

The final outcome:
At the completion of casting, the foot appears to be overcorrected into abduction with respect to normal foot appearance during walking. This is not in fact an overcorrection. It is actually a full correction of the
foot into maximum normal abduction. This correction to complete, normal, and full abduction helps to prevent recurrence and does not create an over-corrected or pronated foot (22).

References.


